Chapter 4

four independent (but connected) mechanisms. My reasons for postulating four distinct modules stem from the evidence from neuropsychology—specifically from the pathologies of autism and blindness, in which these four mechanisms come apart or “fractionate” from one another. I hope to show that there cannot be just one big mechanism. Rather, it appears that Nature can be divided along clear seams, as shown in figure 4.1.

Chapter 5

Autism and Mindblindness

Imagine a hypothetical being who knows nothing of internal mental states. . . . Such a being might be able to remember, know, and learn, but it would possess no understanding of these activities. The social world, the world of self and others, would be an impoverished place for such a creature. . . . Persons would be seen and heard but there would be no notion of a backlog of ideas and beliefs organizing their actions and personalities. Indeed, for this hypothetical being, no one could be construed as possessing private persona; public present behavior would have no deeper meaning. The concept of a lie would be inconceivable, as would . . . notions such as illusions, beliefs, hunches, mistakes, guesses, or deceptions. It is almost impossible to imagine what such a perspective would be like, how such a creature would view the world. (Wellman 1985, pp. 169-170)

When Henry Wellman wrote these words, he did so having spent many years documenting the evidence for normal children’s astonishing competence at mindreading as they develop. For Wellman, the idea of a “hypothetical being” who could not mindread was almost incredible; he proposed the above thought experiment mainly for the purpose of drawing our attention to what life would be like without this remarkable ability.

And remarkable it is. By the end of the first year of life, normal infants, according to the evidence presented in the last chapter, can tell that they and someone else are attending to the same thing, and can read people’s actions as directed at goals and as driven by desires. As toddlers, they can pretend and understand
pretense. And by the time they begin school, around age 4, they can work out what people might know, think, and believe. According to the model I have outlined, this is due in part to the maturing of four mechanisms that the infant has pre-wired into its brain—its inheritance from a long evolutionary history.

For this model to approach the truth even remotely, each of the four systems should, in principle, be open to damage, the nature of the consequent disability depending on which system is damaged. In this chapter I am going to argue from existing evidence that there are real children—not hypothetical beings—who suffer from mindblindness as a result of damage either to SAM or ToMM. These are children with autism. In contrast, I am going to stress how children with congenital blindness are surprisingly able to mindread, because they have an intact SAM and ToMM despite having no EDD.

A Brief Picture of Autism

Autism is considered the most severe of all the childhood psychiatric conditions. Fortunately, it occurs only rarely, affecting between approximately 4 and 15 children per 10,000. It occurs in every country in which it has been looked for, and across social classes. The key symptoms are that social and communication development are clearly abnormal in the first few years of life, and the child’s play is characterized by a lack of the usual flexibility, imagination, and pretense.

The condition may be associated with many biological abnormalities, such as epilepsy, mental handicap, and a variety of brain pathologies. It also appears that in many cases there is a genetic basis to the condition, since the risk of autism or related problems in identical twins or biologically related siblings is substantially higher than would be expected if autism just struck “by chance.” At present, autism is unfortunately a lifelong disorder. Thankfully, it sometimes appears to alleviate a little with age, as the child receives the benefits of a range of educational and therapeutic interventions and learns various strategies for adapting to the social world. It is also possible that the improvements with age reflect changes in the underlying pathology, such as might occur if mechanisms began working after a substantial delay rather than being permanently damaged.

The best way to get a sense of what a child with autism is like, if you have never met one, is to read extracts of Kanner’s (1943) descriptions of the children in whom he first identified the syndrome:

He seems almost to draw into his shell and live within himself.

When taken into a room, he completely disregarded the people and instantly went for objects.

When a hand was held out to him so that he could not possibly ignore it, he played with it briefly as if it were a detached object.

He did not respond to being called, and did not look at his mother when she spoke to him.

He never looked up at people’s faces. When he had any dealings with persons at all, he treated them, or rather parts of them, as if they were objects. He would use a hand to lead him. He would, in playing, butt his head against his mother as at other times he did against a pillow. He allowed his boarding mother’s hand to dress him, paying not the slightest attention to her.

... on a crowded beach he would walk straight toward his goal irrespective of whether this involved walking over newspapers, hands, feet, or torsos, much to the discomfort of their owners. His mother was careful to point out that he did not intentionally deviate from his course in order to walk on others, but neither did he make the slightest attempt to avoid them. It was as if he did not distinguish people from things, or at least did not concern himself about the distinction.

Kanner’s descriptions pick out the same essential qualities of autism as more recent clinical accounts do, such as those of
Baron-Cohen and Bolton (1993), extracts from which follow:

... he never really seemed to look at anyone directly. Rather, he would look at them only fleetingly or else not at all. Despite this, John seemed to notice everything in minute detail. He could ride his bicycle along the most crowded pavements without knocking anyone over, and he spotted car number plates with a figure four in them long before anyone else had noticed. He would also do things his parents found embarrassing, like grabbing and eating sandwiches from a stranger’s plate at restaurants.

He was very good with his number work and took a great delight in learning multiplication tables. He was also still very quick at jigsaws and could manage even difficult puzzles quite easily: at six years old, he did a 200 piece jigsaw puzzle on his own, and a 100 piece one upside down! Socially, however, he was unable to make any friends whatsoever. He would attempt to join in a game that he liked, but his approaches were so odd that other children tended to ignore him. Most of the time, John was to be found on his own, busying himself with one of his special interests, more absorbed in counting lamp posts than playing with other school children.

She took great interest in the smell of everything, sniffing food, toys, clothes and (to her parents’ embarrassment) people. She even tried to smell strangers in the street. She also liked the touch and feel of things—especially sandpaper. In fact, she insisted on carrying around a small piece of sandpaper in her pocket. Strangely though, she took no interest in the cuddly toys she was given. Lucy’s desire to touch and feel things was also a source of embarrassment to her parents. She often tried to stroke stockings on women’s legs, even if they were complete strangers. If they tried to stop her, she would have a tantrum.

The key features of the social abnormalities in autism that these descriptions pick out include lack of normal eye contact, lack of normal social awareness or appropriate social behavior, "aloneness," one-sidedness in interaction, and inability to join a social group.

In 1985, Uta Frith, Alan Leslie, and I proposed that three of the cardinal symptoms in autism—the abnormalities in social development, in communication development, and in pretend play—might be the results of a failure in the development of mindreading. In this chapter I examine this claim with respect to the model I proposed in chapter 4. What is the evidence that children with autism are mindblind? And what is the evidence for the functioning or malfunctioning of each of the four mechanisms in these children?

Autism and ID

Since ID was the first of the primitive mechanisms postulated for normal development, I begin with an examination of how it functions in autism. Recall that ID essentially interprets stimuli in terms of goals and desires—the volitional mental states. Can children with autism understand volitional mental states?

The existing evidence appears to show that children with autism are able to do this—that ID is intact in these children. First, these children use the word “want” in their spontaneous speech (Tager-Flusberg 1989, 1993) and when describing picture stories involving agents (Baron-Cohen, Leslie, and Frith 1986). They say things like “She wants the ice cream” and “He is going to go swimming,” identifying desires and goals, respectively. Second, they can distinguish animacy (Baron-Cohen 1991a), which is close to the class of agency, which itself is one of the basic categories that ID picks out. Third, they can understand that desires can cause emotions—that someone who gets what he wants will feel happy, and someone else who does not get what he wants will feel sad (Baron-Cohen 1991b; Phillips 1993; Tan and Harris 1991). For all these reasons, I suggest that ID is probably functioning normally in children with autism. This does not mean that they are able to understand all aspects of desire, or the more complex mental state of intention. (Phillips...
(1993) suggests that the latter may be linked to epistemic mental states, such as belief.)

**Autism and EDD**

In chapter 4 I distinguished the functions EDD has when it is working alone (as in early infancy) from the functions it has when it is connected to SAM (from toddlerhood on). Regarding its early, basic functions, I interpret the existing evidence as showing that EDD may be intact in children with autism.

They are able to detect when a person in a photograph is “looking at them” (Baron-Cohen, Campbell, Karmiloff-Smith, Grant, and Walker, in press). Furthermore, they interpret eye direction in terms of someone’s “seeing” something. They use the word “see” in their spontaneous speech (Tager-Flusberg 1993; Baron-Cohen, Leslie, and Frith 1986), and they can work out what someone else is looking at when asked to do so (Hobson 1984; Baron-Cohen 1989a, 1991c; Tan and Harris 1991). This is something of a geometric exercise, and their geometric understanding of gaze direction is quite reasonable. For example, when asked which of three colored pegs a person in a photo is looking at, children with autism can answer correctly both in the easy case shown in the upper panel of figure 5.1 and in the more difficult case shown in the lower panel (Leekam, Baron-Cohen, Perrett, Milders, and Brown 1993).

Thus, the basic functioning of EDD seems to be normal in children with autism. Whether such children show the normal pattern of physiological arousal during eye contact (i.e., when EDD is working) has not yet been studied, however. And, of course, in order to assess the evidence for the more complex functions of EDD in autism, we need to bring in SAM.

**Autism and SAM**

Recall that SAM’s principal function is to build triadic representations, which are needed to specify and verify that the self and another agent are attending to the same object or event. All the

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**Figure 5.1**

Two examples of photos used in the geometric test of eye-direction detection. Reproduced from Leekam et al. 1993.
available evidence points to a massive impairment in the functioning of SAM in most children with autism.

Children with autism often do not show any of the main forms of joint-attention behavior. Thus, they do not show gaze monitoring (Leekam et al. 1993; Mundy et al. 1986; Loveland and Landry 1986); nor do they show the related behaviors of attempting to direct the visual attention of others by using the pointing gesture in its “protodeclarative” form (Baron-Cohen 1989a; Mundy et al. 1986; Curcio 1978). This is not because they cannot point at all—they do use the pointing gesture for some other, non-joint attentional functions, such as to request objects that are out of reach (Baron-Cohen 1989a) and to identify different items in an array, for themselves (Goodhart and Baron-Cohen 1993). And not only is the protodeclarative pointing gesture missing in young children with autism, but so are other declarative gestures, such as the showing gesture (which young normal toddlers use simply to show someone else something of interest).

I assume that this is not just a deficit of joint visual attention but, rather, a central problem in the workings of SAM. SAM’s key function is to provide a drive toward establishing what is of shared interest between the self and another person—to try to get on to someone else’s wavelength, as it were. SAM aims to build triadic representations in whatever modality it can. In the blind, who obviously lack EDD, SAM still appears to function, via touch and hearing, as best it can. Blind children establish joint attention via touch, by taking one over to an object and putting one’s hand on it. They also direct one to look at something by using the words “see” and “look.” Landau and Gleitman (1985) report that a girl blind from birth produced the following phrases at the ages noted:

See? It’s in my lap. (36 months)
Look what I have! (36 months)
Look how I do it! (36 months)
See camera! (37 months)
Look, I got Legos. (39 months)

This blind child also responded correctly to the instructions “Let Mommy see the car” (figure 5.2) and “Make it so Mommy cannot see the car” (figure 5.3), which suggests that, although she could never have had a normal sense of what it means for another person to see an object visually, she had a pretty good idea of what “see” means in an amodal sense: to apprehend, or to explore perceptually, or to have available to one of the sensory modalities (ibid., pp. 75, 77). Indeed, one blind adult gave a wonderful definition of the word “gaze”: “To look at something intensely. An equivalent would be to listen to something very hard.” (ibid., p. 96)
In most children with autism, SAM does not appear to be working through any modality—vision, touch, or audition. By and large, they bring an object over to someone, or point an object out, or lead someone to an object and place the person's hand on it, only when they want the person to operate that object or to get it for them. This is not shared attention in any sense; these behaviors are primarily instrumental, and do not indicate a desire to share interest with another person for its own sake.

Furthermore, one symptom in autism looks very much like a reflection of a failure to establish joint auditory attention: children with autism often speak too loudly, or too softly, or with little intonational inflection (Frith 1989). I suspect that normal children modulate their intonation to make their speech interesting and audible to the listener, and that children with autism do not because they lack a concept of the other person as an interested listener.

For these reasons, I suggest that in autism the deficit in joint visual attention stems from a deeper impairment in SAM, and that this has two consequences: triadic representations cannot be built in any modality, and there is no output from SAM to trigger ToMM. The prediction that arises from this claim is that in autism virtually all aspects of ToMM should be impaired.

**Figure 5.3**
A blind child responding to the instruction “Make it so that mommy cannot see the car.” Reproduced from Landau and Gleitman 1985.

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**Autism and ToMM**

*Representing the Full Range of Mental States*

If ToMM is dysfunctional in children with autism, then they should clearly have difficulty understanding the epistemic mental state of belief. Dennett (1978b) argued that the best way to test a child’s understanding of belief is to investigate if the child can understand that someone might hold a false belief—indeed, he suggested, this might constitute a litmus test of whether an organism had a “theory of mind,” in that in such cases it becomes possible to distinguish unambiguously between the child’s (true) belief and the child’s awareness of someone else’s
different (false) belief. Wimmer and Perner (1983) followed this suggestion by designing a “false-belief test,” which they used with normal children (figure 5.4). They showed that around the age of 3–4 years normal children pass such a test. Alan Leslie, Uta Frith, and I adapted this test for use with children with autism, children with Down’s Syndrome, and normal children (Baron-Cohen, Leslie, and Frith 1985).

The test involves seeing that Sally puts a marble in one place, and that later, while Sally is away, Anne puts the marble somewhere else. The child needs to appreciate that, since Sally was absent when her marble was moved from its original location, she won’t know it was moved, and therefore must still believe it is in its original location. (Notice the resemblance between this little story and the Snow White fairy tale, in which Snow White was absent when her wicked stepmother put on her disguise and therefore doesn’t know that the old woman selling apples at her door is really her wicked stepmother.)

On the test question “Where will Sally look for her marble?” the vast majority of normal children and children with Down’s Syndrome passed the test, indicating the original location. But only a small minority of the children with autism did so. Instead, most of them indicated where the marble really was. This pattern of results is also found when the wording of the test question is “Where does Sally think the marble is?” Since the children with autism were older and had a higher “mental age” than the children in either of the two control groups, this study supports the notion that in autism the mental state of belief is poorly understood. This result has now been replicated many times.

Using a totally different test (the “Smarties test”), Perner, Frith, Leslie, and Leekam (1989) got the same basic result. In this test, the child is first shown a familiar Smarties container and is asked “What do you think is in here?” The child naturally replies “Smarties.” The child is then shown that the tube actually contains pencils. Next the experimenter closes the tube and asks the child two “belief questions.” The first question is “When I first showed you this tube (before we opened it up) what did you think was in here?” The normal child, of course, correctly replies by referring to his or her earlier, now false belief: “Smarties.” The experimenter follows this up with: “And when the next child comes in (who hasn’t seen inside the tube), what will he think is inside here?” Again, the normal child correctly replies by referring to the other child’s false belief: “Smarties.” When Perner et al. gave this task to children with autism, they found that the majority of their subjects answered “Pencils” to the two belief questions. That is, they answered by considering their own knowledge of what was in the box rather than by referring to their own previous false belief or to someone else’s current false belief. The robustness of this finding suggests that in autism there is a genuine inability to understand other people’s different beliefs.

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**Figure 5.4**
A schematic summary of the “Sally–Anne Test” of understanding false belief. (C = child; E = experimenter.) Reproduced from Baron-Cohen, Leslie, and Frith 1985.
In another study, Frith, Leslie, and I tested this again, this time using a largely non-verbal method (Baron-Cohen, Leslie, and Frith 1986). We used a picture-sequencing test in which picture stories (each four frames long) depicted, when correctly sequenced, either a character’s false belief (figure 5.5), a character’s desires and goals (figure 5.6), or a character’s causal actions on an inanimate object (figure 5.7). Again, the children with autism performed very poorly on the stories involving an understanding of belief, although they were at least as good as the children with Down’s Syndrome or the normal controls at sequencing the stories involving the character’s desires and goals. This again shows ID working normally in these children, while ToMM is specifically impaired. The children with autism were also fine at sequencing the stories involving physical causality (which did not require any understanding of mental states). This demonstrated that the autism-specific deficit in understanding beliefs as psychological causes of behavior was not due to general demands of language or to an inability to understand causality. It also ruled out a general sequencing deficit, contrary to earlier reports.  

Although most children with autism fail tests of belief understanding, a minority of them pass. This subgroup ranges from 20 to 35 percent in different samples. Moreover, that these subjects tend to be the same subjects in different tests leads to the conclusion that, on the face of it, the members of this “talented minority” (as Uta Frith calls them) have an intact understanding of belief. In a later study, however, this was shown to be the result of a “ceiling effect”: passing the Sally–Anne test does not imply that they have a normal ToMM, since most false-belief tests are set at an equivalent mental age of about 3–4 years and the mental ages of the children with autism we tested were well above this (Baron-Cohen 1989b). The task we used in this later study, designed for normal children by Perner and Wimmer (1985), is a more taxing test of belief understanding. To pass it one must understand nested beliefs, or beliefs about beliefs (e.g., “Anne thinks that Sally thinks x”)—these being well within the comprehension of normal 6–7-year-olds. Most teenagers with
Figure 5.6
Picture-sequencing test involving stories centering on a character's desires and goals. Adapted from Baron-Cohen, Leslie, and Frith 1986.

Figure 5.7
Picture-sequencing test involving stories centering on physical causal events. Adapted from Baron-Cohen, Leslie, and Frith 1986.
autism failed this outright, despite having a language level at least equivalent to a 7-year-old's (Ozonoff, Pennington, and Rogers 1991; Holroyd and Baron-Cohen 1993).

Thus, it appears that most children with autism do not understand beliefs at the equivalent level of normal 3-4-year-olds, but some do; yet even the latter show impaired understanding of beliefs at the equivalent level of normal 6-7-year-olds. (A very small minority of individuals with autism pass tests of ToMM even at the 7-year level. I will discuss one such individual in chapter 8, since this raises the question of whether this severe deficit can be overcome or circumvented.)

Understanding knowing appears to be easier than understanding belief for normal children. Why this should be so is not completely clear; however, some authors give as the reason that, since knowledge is true belief, this should be simpler than false belief (as misrepresentation is not involved).

Leslie and Frith (1988) tested whether children with autism understood knowing. The child was shown an actor watching the experimenter hiding a “counter” (a plastic token). When the actor left, the experimenter asked the child to put a second counter in a second hiding place. The child was then asked where the actor would look for a counter on her return. Leslie and Frith found that only about half of the children with autism passed this test by indicating the place the actor knew about rather than the place she was ignorant about. Since only about a quarter of them passed a false-belief task, these findings suggest that understanding knowing is slightly easier than belief for children with autism, but that the majority of them show deficits in comprehension of both mental states.

Building a Theory of Mind

What else might we expect to see, if ToMM was damaged in children with autism? According to the model outlined in chapter 4, we should also expect to see that the mentalistic “theory” that normal children possess would be missing or disturbed. For example, we should expect their understanding of some of the basic axioms of the theory to be shaky or absent. One central axiom is that seeing leads to knowing. Given the evidence that understanding knowing seems beyond most children with autism, one might expect this principle to be beyond them. Perner et al. (1989) tested this by showing subjects an object being hidden, but not showing a confederate. They then asked the child who knew what was hidden and who had been allowed to look. Although the vast majority of children with autism passed the “look” question, only about half of them passed the “know” question. Frances Goodhart and I replicated this (Baron-Cohen and Goodhart 1994), using the wonderfully simple method that Pratt and Bryant (1990) had used with normal 3-year-olds. After a subject has seen one of two actors look into the box and the other one simply touch the box (figure 5.8), the subject is asked which of the two actors (or story characters) knows what is in the box. This paradigm thus controls for the child’s simply choosing the character who did something to the box. Only a third of children with autism passed this test, whereas three quarters of children with a mental handicap passed.

Additional indirect evidence that this principle poses difficulties for children with autism comes from a naturalistic study of deception in autism (Baron-Cohen 1992) in which the child was asked to hide a penny in one hand. Across a series of trials, the children with autism succeeded in keeping the object out of sight but failed to hide the visible clues that would enable the guesser to infer (know) the whereabouts of the penny (e.g., they...
omitted to close the empty hand, or hid the penny in full view of the guesser, or showed the guesser where the penny was before he had guessed). Children with mental handicap (but not autism) and normal 3-year-olds made far fewer errors of this sort. For them, the game was fun if they succeeded in keeping information about the whereabouts of the penny out of the guesser's mind. This study adds to the data on deception deficits in autism (Oswald and Ollendick 1989; Sodian and Frith 1992, 1993).

A second aspect of the normal child's theory of mind is the ability to apply an understanding of beliefs to the realm of emotion. Normal children can recognize not only simple emotions (such as happiness and sadness) but also belief-based emotions, such as surprise. When we tested this in children with autism, it turned out that they too could recognize the simple emotions, but they had difficulty in recognizing the belief-based emotion of surprise (Baron-Cohen, Spitz, and Cross 1993). Viewing photos like those shown in figure 5.9, most children with autism were able to match happy and sad, but significantly more children with autism made errors in matching pictures of surprised expressions. They sometimes mistook these for non-cognitive states such as yawning or being hungry, focusing on the open mouth.

Some studies have examined the prediction of emotion rather than its recognition. The aim in these studies is to establish how much a child with autism understands about the causes of emotion—how he or she will feel, given a set of causal circumstances. Harris et al. (1989) found that normal 3–4-year-olds understood that emotion can be caused by situations (e.g., nice situations make you feel happy, nasty ones make you feel sad) and desires (e.g., fulfilled desires make you feel happy, unfulfilled ones make you feel sad). They also found that by the age of 4–6 years normal children understood that beliefs can affect emotion (e.g., if you think you’re getting what you want, you’ll feel happy, and if you think you’re not, you’ll feel sad—irrespective of what you’re actually getting).

When I tested whether children with autism were able to judge a story character’s emotion when this was caused by a situation, a desire, or a belief (Baron-Cohen 1991b), I found that they could understand situations as causes of emotion, and that they were as good as a group of mentally handicapped children at predicting the character’s emotion on the basis of the character’s desire. However, they were significantly worse than either normal 5-year-olds or mentally handicapped children at predicting the character’s emotion on the basis of the character’s belief.

A third aspect of the normal child’s theory of mind is the understanding that the brain is an organ with mental functions. In one experiment (Baron-Cohen 1989d), after it was established that they knew the location of the brain, children with autism were asked what they thought the brain was for. In reply, most of them referred to its role in behavior (“It makes you move,” etc.). Only a small proportion of them referred to its mentalistic role (“It’s for thinking,” etc.), even after considerable prompting. In contrast, most of a group of mentally handicapped children and most normal 5-year-olds referred to the brain’s mental function (dreaming, remembering, keeping things secret, etc.).
Another cornerstone of the normal child's theory of mind is the ontological distinction between mental and physical entities. Wellman and Estes (1986) found that normal 3-year-olds had a stable grasp of this distinction. I adopted their method for use with children with autism (Baron-Cohen 1989d). The subject was told a story about two characters: one who had an object and one who was thinking (or dreaming, or pretending, or remembering) about an object. After each story, the subject was asked to make judgements about which character could perform an action on the object—e.g., "Which one can touch the [object]?” Most of the normal children (and most of those with a mental handicap) passed the test, by indicating that it is the one who has the object who can touch it, etc. Only a small proportion of the children with autism did so.14

If ToMM is damaged in autism, then children with autism should also have difficulty in distinguishing appearance and reality. Flavell, Green, and Flavell (1986) showed that, when presented with misleading objects such as a sponge painted to look
like a rock, normal children between 4 and 6 years of age could say not only what it looks like (a rock) but also what it really is (a sponge). In doing so, they distinguished between their initial (perception-based) belief about the object and their current knowledge about it. How would children with autism perform on such a test?

Using the method of Flavell et al., I found that, while most mental handicapped children and most normal subjects were able to answer an appearance question ("What does it look like?") and a reality question ("What is it really?") correctly, once again only a small percentage of subjects with autism were able to do so (Baron-Cohen 1989d). When shown objects with misleading appearances, such as a stone that looked like an egg, most children without autism were able to say (e.g.) "It looks like an egg, but really it's a stone." In contrast, most children with autism made largely "phenomenist" errors, saying "It looks like an egg," "It really is an egg," and similar things. They seemed to be dominated by their perception, and unable to consider their knowledge.

In discussing the appearance-reality distinction, Flavell et al. (1986, pp. 1-20) wrote:

'It is probably a universal outcome in our species. This knowledge seems so necessary to everyday intellectual and social life that one can hardly imagine a society in which normal people would not acquire it. . . . Knowledge about the distinction seems to presuppose the explicit knowledge that human beings are sentient, cognizing subjects . . . . It is part of the larger development of our conscious knowledge about our own and other minds.

If, as appears to be the case, most children with autism really are unaware of the appearance-reality distinction, as well as being blind to their own past thoughts and to other people's possibly different thoughts, their world must be largely dominated by current perceptions and sensations. Further, much of the social world must appear unpredictable and therefore even frightening. In terms of the model, the deficits in SAM and ToMM appear to have widespread but highly specific and predictable conceptual ramifications for children with autism. The consequences discussed here are undoubtedly only a small subset of these; the complete consequences for their cognitive development remain to be explored.

**ToMM in Children and Adults with Congenital Blindness**

From my earlier claims about blind children, one would predict that if SAM is intact in such children then ToMM should also be intact. One might expect blindness to delay the functioning of SAM, since the only input that is available to a blind child comes via ID, and thus it comes as no surprise that a proportion of congenitally blind children initially show some "autistic" features (Hobson 1990; Fraiberg 1977). However, such delays and obstacles to the functioning of SAM clearly should not prevent its eventual functioning, since SAM is held to be intact in such individuals. That ToMM is indeed intact in blind people is obvious from the apparent ability of blind adults to participate normally in social relationships. Some specific evidence comes, again, from an interview with a blind adult, who was asked to define some mentalistic concepts and who defined "to notice" as follows:

*To see something that comes into your view. But not only to see it but to perceive it and understand it. You could sit on this rocking chair and not notice the color of it at all. Might have to be looking at something specifically to notice it.* (Landau and Gleitman 1985, p. 96)

SAM should be intact even in an adult who was born both deaf and blind, although its use would obviously rely heavily on tactile information. In such cases, SAM should therefore be able to trigger ToMM. Here is a definition of "to stare" supplied by one such adult:

*Well, stare means to stare at a person or an object, maybe in surprise or maybe spellbound. For instance, when somebody says something to you and you are shocked at what*
you heard, you stare at the person as if you are asking a person a question, because you can't believe what he has just said. Or to stare, because you are concentrating more deeply into an object. So, you will stare at it, trying to focus your mind on what you are looking at. (reported by C. Chomsky [1984]; cited in Landau and Gleitman 1985)

As the theory predicts, the language of individuals born blind is beautifully laced with the full range of mental-state terms. Tragically, they are missing in the language (Tager-Flusberg 1993) and in the thought of most individuals with autism.

Chapter 6
How Brains Read Minds

A fundamental tenet of evolutionary biology is that there are no sudden qualitative jumps from one species to the next. The human brain is remarkably similar to those of lower primates. Mentalizing abilities did not suddenly develop from nothing. Such abilities result from relatively small improvements in existing mechanisms. In order to understand mentalizing abilities and their relation to the brain we need to identify the precursors of these abilities in animals. (C. Frith, in press)

The mindreading system has, according to the theory I proposed in chapter 4, four separate mechanisms or subcomponents. ID and EDD receive perceptual input directly; SAM and ToMM are more central. So far, I have discussed these four mechanisms only at the cognitive level. The cognitive level is essentially the functional level, and these descriptions typically refer to the flow and processing of information, and how that information is represented. The cognitive level of description is also an example of how scientists adopt what Dennett calls the “Design Stance” (see chapter 3 above) when attempting to work out how the mind functions.

In principle, the cognitive description of the mindreading system that I have given could be a description of an organism with “natural intelligence” (e.g., Homo sapiens), or it could be a description of an “artificially” intelligent system (a robot or a computer). This is because cognitive mechanisms, described in their own right, are only about things like information flow, information processing, and representations of information.

It is now time to talk about the instantiation of these cognitive